ENERGY MATTERS

Formerly Turning Point

An Office of Industrial Technologies
Bimonthly Publication Focusing on
Energy Efficiency Opportunities for Today
www.oit.doe.gov

Notice to Readers

We are introducing some editorial changes in this issue of the newsletter. Our coverage will now include a more comprehensive *energy systems approach* that captures the full spectrum of productivity-enhancing energy efficiency opportunities for industry. As reported in previous issues, in 1998 the U.S. Department of Energy's Office of Industrial Technologies (OIT) together with industrial partners initiated two additional Challenge programs: the Compressed Air Challenge™ *(see March 1998 issue)* and the Steam Challenge *(see May, July 1998 issues).* In upcoming issues, we also will be highlighting the new Combined Heat and Power Challenge (see CHP Summit on page 5), as well as the long-established DOE Industrial Assessment Center (IAC) Program. In covering these activities, this newsletter will continue to emphasize innovative, hands-on examples of how your peers in industry are improving their operations.

In order to address the newsletter to both our traditional and our new audiences, we convened an editorial board on October 13 and 14, 1998. The editorial board comprises industry and program representatives for motor, steam, and compressed air. *(See mast head on page 2 for board members names and organizations.)* During the 2-day meeting, participants discussed the goal of Turning Point, its strengths and weaknesses, its integration of the OIT Challenge programs, layout, themes/topics for the next year, and distribution. To reflect our expanded focus, we considered several new names for the newsletter and have decided to rename it *Energy Matters* to better represent the resources available through the OIT Industries of the Future partnerships that offer a variety of technical assistance to industry.

Another important task of the editorial board was to develop an editorial calendar for the year—Turn the page for your copy of the 1999/2000 Editorial Calendar. Please note that in March and May we will be running supplements on compressed air and steam in addition to our regular feature. News and technical information on all five programs will be in each issue. Future special supplements on Combined Heat and Power and IAC will be added.

Let us know if you would be interested in submitting an article related to any of the editorial features. Send suggestions to:

Julia Oliver
Communications Manager
U.S. DOE
(510) 637-1952 phone
(510) 637-2017 fax
julia.oliver@oak.doe.gov
or…

Erika Ericksen
Energy Matters Editor
National Renewable Energy Laboratory
(303) 275-3914 phone
(303) 275-3619 fax
erika_ericksen@nrel.gov

ENERGY MATTERS 1999-2000 Editorial Calendar

Send suggestions to:
Julia Oliver, U.S. DOE
(510) 637-2017 Fax
julia.oliver@oak.doe.gov
or
Erika Ericksen
(303) 275-3619 Fax
erika_ericksen@nrel.gov

March 1999

Editorial Feature:
Utility Financing and Services

Topics: Site audits and recommendations; financing options; motor/compressors/ HVAC consultations; power quality; preferred providers; third party providers; real-time energy accounting.

Supplement: Compressed Air Systems

Article deadline: 1/29/99

May

Editorial Feature:
Motor, Steam, Compressed Air Systems Management

Topics: Overview article; end user/supplier article; initial purchase specs; repair/ replace; dollars justified to purchase an energy-efficient motor; repair specs; data management; planned upgrades.

Supplement: Steam Systems

Article deadline: 3/23/99

July

Editorial Feature:
Selling an Energy-Efficient Project to Management

Topics: Real-life example of sale; how to talk about real-time money; “how to sell” checklist.

Article deadline: 5/21/99

September

Editorial Feature:
Contracting Services

Topics: Explanation of contracted services; contract services available; how it can benefit plant during downsizing; interfacing with outside contractors; contract maintenance; motor repair services; motor surveys; what vendors are doing to help customer buy most efficient motor; steam contract services and traps.

Article deadline: 7/21/99

November

Editorial Feature:
New/Applied Technologies

Topics: What are the new technologies to help save energy; applied technologies; burner management; vendor/end user story.

Article deadline: 9/22/99

January 2000

Editorial Feature:
Reliability Based Maintenance (RBM)

Topics: Introduction and definition of terminology; methodology; 20%/80% rule; when to apply; routine maintenance schedules (trending); case treatment.

Article deadline: 11/19/99

March

Editorial Feature:
ASD Technologies

Topics: Motor/pump/drive relationship; repairing motors to be operated with ASDs; when to use; when not to use; picking pumps (fixed vs. variable).

Article deadline: 1/21/00

ENERGY MATTERS

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GM Seizes Opportunity to Improve System Efficiency and Save Energy and Money

GM's Pontiac Complex

As the world's largest automobile manufacturer, General Motors (GM) accounts for almost 33% of cars and light trucks sold in the United States. But even that doesn't stop them from looking for ways to improve system efficiency. When it came time to relocate the water booster pumping system, GM designed and built a more energy-efficient one in its Pontiac Operations Complex, cutting energy consumption by over 80% (225,100 kWh per year) and saving over $11,000 annually. With a capital investment of $44,966 in the energy efficiency portion of the system, this translated to a payback period of 4.0 years.

GM took advantage of an opportunity to save money and energy when renovations to its Pontiac Complex required the relocation of the facility's city water booster

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In This Issue

Order Your Copy Now

Don't forget to order your copy of the *United States Industrial Electric Motor Systems Market Opportunities Assessment* by calling (800) 862-2086. The report details motor-driven system use in the industrial sector. You can find out what the key motor system energy saving opportunities are in your industry. And, you can use the report to benchmark your current motor system purchase and management procedures against concepts of best practice. The report contains valuable facts such as:

- Improvements to the major fluid systems (pumps, fans and compressors) represent 62% of potential savings.
- Typical savings for an industrial facility are around $90,000 per year; for paper mills, petroleum refineries, and inorganic chemical plants (the three highest motor system energy consuming industry groups) the annual savings are $659,000, $946,000, and $283,000, respectively.
- Potential industrial motor system energy savings using mature, proven, cost-effective technologies equal roughly 11% of current annual usage or 75 billion kWh per year.
- Motor systems used only for production processes consumed 23% of all electricity sold in the United States.
- And much more.

You may order either the Executive Summary or the entire report from the Clear-inghouse at (800) 862-2086.

You can also access the Web site at www.motor.doe.gov/mcnew.htm for the Executive Summary and Sections 1-4 of the report.

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COMMENTS?

Contact:

Julia Oliver, DOE, at
(510) 637-1952, or e-mail
julia.oliver@oak.doe.gov

Erika Ericksen,
Energy Matters Editor, at
(303) 275-3914, or e-mail
erika_ericksen@nrel.gov
1617 Cole Blvd., MS 1713
Golden, CO 80401

GM Improves System Efficiency

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pumping system. Partnering with Detroit Edison on this Motor Challenge Showcase Demonstration project, GM replaced the original system's five 60- to 100-hp pumps with three 15-hp pumps whose speed could be adjusted to meet plant requirements. Detroit Edison evaluated cost-savings opportunities by monitoring electricity consumption prior to system upgrades and again after the project was completed. In addition to Detroit Edison's help, U.S. Electrical Motors supplied the motors to drive the pumps. In particular, a new switch reluctance prototype motor design was installed on one of the pumps.

As the water demands of the plant decreased over time, the original system only used a single 100-hp pump and even it was oversized. The pump operated continuously, even during plant shutdowns. The team felt GM could achieve significant savings by closely matching the installed pumping capacity to the actual demand for water. Also, eliminating the holding tanks used in the previous system and tying the pumping system directly to the city water enabled the system to take advantage of the available city water main pressure. And instead of using a recirculating flow line to modulate the flow to the plant, the project team decided to vary the motor speed to match the pumping requirements to the flow demand. Two of the pump motors used VFDs and the third a switched reluctance unit. This pump-speed modulation provided additional operating cost savings through improved flow control. Finally, with the new city water pumping system located one-half mile closer to the facility's primary water demand location, pipe friction head loss was decreased.

Water Booster Pumping System

The use of three smaller pumps provided another performance improvement over one large pump. During any 24-hour period, a single pump operated as the lead pump with the other two serving as backups in case additional pumping was required or the lead pump failed. Every 24 hours, a different pump was designated as the lead pump, so each pump had equal running time. This set up improved system reliability and flexibility, allowing one pump to be isolated from the system for maintenance or repairs while the others served the complex.

The GM project shows how companies can capture opportunities to improve system performance and achieve the corresponding benefits. The technologies used in this project are not unique; VFDs can be applied to many pumping systems. Their high operating efficiencies and ability to match flow energy to system requirements can result in substantial cost savings.

Will Electric Power Reliability Change with Restructuring?

By John Kueck, Manager of Electric Machinery Center, Oak Ridge National Laboratory, Oak Ridge, TN

Restructuring of the United States' electric utility industry is progressing at different speeds across the country. After restructuring has been completed in an area, control of the grid becomes the responsibility of the Independent System Operator (ISO). In California, an ISO is controlling the power flow for the entire state, and a Power Exchange has been established that is providing the mechanism for commercial power transactions in the state. In Alabama, Georgia, and Tennessee, restructuring is only in the discussion stages. This disparity possibly may be attributed to customers in these southern states not having the same level of concern with their electric rates as customers in California, the Northeast, and central Midwest.

Will the trend to restructuring or this difference in the rate of restructuring result in any impact on reliability? In theory, restructuring should actually improve the reliability of the bulk power system because control of the grid will be performed much more rigorously and over a wider area. The ISOs use state-of-the-art computer systems to monitor and continuously analyze the health of the grid. In general, the areas of the country where restructuring has not taken place are typically controlled by central control areas. These function in much the same way as an ISO, but over a smaller area, with commercial ties to generation, and not always with the same degree of rigor.

There is an interesting issue, however, that is developing in parallel with restructuring. In a restructured system, electrical reserves are supplied by separate commercial entities, whereas, in the past, the generation suppliers had enough reserves to serve the needs of the area. Many utilities are no longer building large scale generating capacity because of a number of constraints—inability to find suitable sites, environmental concerns, and uncertainty over the future of a deregulated industry. In addition, some of the larger generating stations around the country have been out of service for modifications or other reasons. But, in theory, this should not be a problem because regulations require that a certain amount of reserve generating capacity always be maintained.

In areas that are controlled by ISOs, reserve generation is now purchased as a service instead of just being supplied by the utility as part of doing business. Independent providers are setting up shop just to provide this type of service. Occurrences in Illinois and California last summer showed that, when needed, this reserve generation will be purchased regardless of the price. These two occurrences last summer happened when reserve generating capacity was needed for reliable operation of the grid, but there were very few suppliers on the market. Those suppliers who had generating capacity essentially had a corner on the market for a short time and demanded extremely high prices for their service. They were paid, and the margin was maintained, but there has been some concern about the level of reserve margin available in some regions.

What's the Risk?

One area where more frequent interruptions may likely occur is for customers who have reduced their electric rates by using the special interruptible load rate. This special rate is for customers that have a manufacturing or agricultural process that can be interrupted occasionally with no significant economic impact, and who want to have lower rates in return for having their power interrupted occasionally. These customers, in the new deregulated scheme of things, may be looked on as reserve margin. In the past, this type of customer was rarely dropped because even though he was interruptible, he was still a ratepayer. The new philosophy of reliable grid operation is to maintain the security of the transmission system (the backbone) of the grid at all times, and, if needed, to cut load to accomplish this. The first loads to be cut, in the event of a disturbance, are going to be the interruptible loads.

During the June 27, 1998, California heat wave that resulted in malfunctions at several generating stations, the ISO called for dropping the interruptible load to ensure that the margin of generating reserve was maintained. Exactly how much this service interruption is used in a deregulated market is, in the long term, going to depend on market forces. However, as the market becomes "leaner," customers who opt for interruptible service may want to consider that interruption, as a method for ensuring reserve margin, may be on the increase.

What's the Opportunity?

In fact, with restructuring, there may be possibilities for large electricity consumers to become a player on the new markets. Customers with large amounts of load that could be scheduled a day in advance may be able to take advantage of restructuring to schedule their load usage so they could contract for these large load blocks to be turned off if needed. They may then be able to sell these blocks to the system as reserve rather than using the traditional interruptible rates.

Note: For those interested in finding out more on the California ISO, check out the Web site at http://oasis.caiso.com/.

Send comments or questions to the author at Ku5@ornl.gov.

Terminology

Spinning Reserves—unloaded generation, which is synchronized and ready to serve additional demand.

Non-Spinning Reserves—operating reserve that is not connected to the system, but capable of serving demand within a specific time.

Energy and the Pulp and Paper Industry—How Will Electric Utility Deregulation Affect You?

by Christine Greenberg

Originally published in TAPPI JOURNAL, *Vol. 81, No. 3*

Another evolution in American industry is taking place and it involves our source of power. Deregulation of the existing electric utility industry is coming quickly and will have a major impact on all industry manufacturers. How will this deregulation take place? What effect will it have on electricity prices and reliability? How can the pulp and paper industry take advantage of it? The coming evolution has the potential to lead to a new cycle of prosperity and growth. The following examination of the market forces driving this evolution suggests that we may be able to take advantage of the coming changes to generate increased value.

Energy in the Pulp and Paper Industry

So what is happening in the pulp and paper industry? Energy is certainly a key component, comprising 15-30% of product cost. Clearly, the procurement and use of energy need to be effectively managed to minimize the impact on the product's profit margin. Energy is also a product, as by-products of the manufacturing process serve as raw materials for energy production (e.g., biomass, hog fuel, and black liquor). Although energy production and use are core to the manufacturing process, energy strategies need to be constructed around the core business of pulp and paper manufacturing.

Energy has traditionally been procured only through the available channels: make it or buy it from your local utility provider. There are huge regional variations in delivered energy cost. This places regional margin pressures on pulp and paper producers and complicates the "make it or buy it" decision-making process. Negotiations with local utilities have been sporadic and opportunistic, and the utilities have been both cooperative and antagonistic in their responses.

The pulp and paper industry needs better than 90% uptime to break even, and any reliability issues introduced by energy production or supply could have severe consequences. The industry is using a greater degree of computer-based control products, and the definition of electric supply reliability is changing from minutes per outage to number of cycles per outage. Greater pressures exist for uninterruptible supply.

Capital effectiveness is appropriately the current hot term in the industry. The industry-wide return on capital lags behind the chemical and allied products industry average by all measures. Energy assets consume 20-30% of capital spending in the industry and comprise a significant portion of the existing asset base. The fleet is aging; environmental pressures loom. The need for significant investment in infrastructure improvements and replacement takes necessary and increasingly scarce capital away from the core pulpmaking and papermaking processes.

Environmental pressures on the pulp and paper industry are a way of life. The industry has done well to promote the stewardship of its vital forest, water, and air assets. The very renewable nature of wood products may help extend their product life cycles. Similarly, energy produced with renewable resources, such as trees and hydroelectric power, may command a premium in the future electric marketplace. In the interim, however, licensing for hydroelectric plants is becoming prohibitively cumbersome, and proposed restrictions on particulate emissions may greatly restrict the use of wood-fired boilers.

Convergence: What can the Electric Industry Provide that the Pulp And Paper Industry Needs?

To take full advantage of the changes, the pulp and paper consumer needs something different. He needs innovative products that are specifically designed for each consumer. The new products and services will need to fill a unique niche at each unique mill site and must be capable of responding to those differences. For example, an electric supply contract with 100% firm delivery may be required at one mill, *while* a mill with on-site generation may only need a portion of its energy contract to be firm. Similarly, in a mill that runs several grades, a fixed monthly energy price, regardless of use, may allow a more favorable product cost allocation, whereas a mill running only one grade may want a pay-as-you-use type of contract.

The companies that deliver the new products and services need to continue to push the envelope of innovation in discovering the optimal solution. They also need to acknowledge the immense knowledge base that already resides in the pulp and paper industry, and tap into that resource to ensure practical and workable solutions. New providers need to be responsive, flexible, and forthright.

New channels of delivery will need to be developed. The traditional methods of supply contracts, capital upgrades, and project financing need to evolve. For example, a mill may be limited in production due to its steam production capability. The mill could fill this need with a capital investment in a boiler upgrade through traditional vendors. Another option is for the mill to turn to an energy services provider, who will sell it steam at the point of use. A mill with multiple fuel capabilities may continue to purchase fuels from several vendors, or it may turn to a financial institution to provide a fixed cost/Btu "price hedge," leaving the risk manager with the responsibility to negotiate the appropriate fuel supply contracts.

The disaggregated electric utility industry, together with the pulp and paper industry, needs to consider "virtual" vertical integration. Perhaps the cogeneration units at the mill become the"GENCO" for the local distribution company to serve the local community. Or, the pulp mill may become the fuel supplier to the GENCO, which in turn supplies power to the converting facility. The notion of "energy is

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energy' needs to be fully exploited, with novel tolling arrangements and buy/sell, point-of-use, and other contracts being developed.

Pulp and paper companies and energy companies need to migrate from provider (traditional contractual) relationships to partner relationships. The limited scope of supply and proprietary nature of traditional relationships need to be replaced with flexible arrangements with full-service suppliers, who are prepared to capitalize on shared skills and technologies, and focused on filling the need instead of the requirement. New relationships should be performance based, where both partners will derive benefits from improved performance.

Conclusion

Potential opportunities resulting from the deregulation of the electric utility industry abound. The pulp and paper industry is an important energy consumer and needs to leverage its position to influence the evolution of the deregulated energy marketplace. The electric utility industry needs to be prepared to respond with innovative products and services, delivered in a nontraditional manner through nontraditional channels. Each industry needs to closely examine the competencies that are resident in the other. Both need to work together to forge solutions that will propel them into future profitability.

Understanding Deregulation (Originally published in *TAPPI JOURNAL*, Vol. 81, No. 3)

Pulp and paper companies have traditionally been vertically integrated. They owned the forest, the equipment to harvest the trees, the woodyard, the pulp mill, the paper mill, the converting facilities, and even some distribution and merchant companies. Recently, the industry has begun to disaggregate into discrete operations, allowing companies to focus on specific markets and manufacturing processes with the hope of leading to higher profitability. Meanwhile, regulatory and legislative initiatives are being promulgated to encourage a similar disaggregation of the vertically integrated electric utility industry into a group of GENCOs (generating companies to make power), TRASCOs (transmission companies to move power), and DISCOs (distribution companies to deliver power).

The move toward less regulation started in 1992 when the Energy Policy Act enabled wholesale trading of electricity. An active market has developed, with most of the trading occurring between regulated investor-owned utilities, municipal utilities, and rural electric co-ops. In 1996, the Federal Energy Regulatory Commission (FERC) enacted new rules, Orders 888 and 889, which provide "open access" to transmission systems. These orders are intended to enable additional parties to have access to the wholesale electric market and to the "captive" transmission assets owned by the electric utility industry. Independent power producers, merchant plants, and other qualifying GENCOs are now guaranteed equal access to transmission assets.

Independent systems operators (ISOs) have been established to ensure fairness in access to transmission assets. These ISOs—or in some areas, a power exchange or pool—will be responsible for dispatching generating assets on an economic basis, thus ensuring that all generators bidding into the market enjoy an equal opportunity to participate.

Deregulation of the retail electric market is taking place substantially at the state level, although two national initiatives have been proposed. As of August 1997, 16 states have passed or are actively considering retail open access, with implementation time lines ranging from 1998 to 2000. The definition of retail open access varies from state to state, but there are some important similarities:

- *Utilities will "unbundle" their rates into basic components of generation, transmission, and distribution.*
- *Customers will be permitted to choose their generation supplier.*
- *Existing utilities will be compensated for their "stranded" assets.*
- *Regulated utilities will maintain distribution rights for their franchise territories (a local distribution company, or LDC).*
- *A default generation provider will be designated and will have an obligation to serve.*

December Summit Produces Goal to Double Combined Heat and Power Systems

A recent summit, held December 1, 1998, in Arlington, Virginia, resulted in strong support from governmental, nongovernmental, international, and industry representatives for increasing the deployment of Combined Heat and Power (CHP) systems. Nearly 200 attendees recognized CHP, also known as cogeneration, as a way to improve local economic development while reducing the environmental risks from burning fossil fuels. Conference Chair Dan Reicher, Assistant Secretary for Energy Efficiency and Renewable Energy at DOE, challenged the United States to double the CHP deployed in the country by 2010 to 46 GW—equivalent to eliminating 40 million cars from U.S. roadways.

Reicher also hailed the formation of the U.S. CHP Association, comprised of energy consumers, system owners, equipment manufacturers and environmental groups. (Access www.nemw.org\uschpa for more information on this association.) Acting chair of the association, Peter Carroll, responded with a similar challenge to increase the electric generation efficiency to 65%—more than double the current U.S. efficiency, but close to the Danish efficiency of 60%. David Doniger, counsel to the U.S. Environmental Protection Agency's administrator for Air and Radiation, echoed Reicher's praise for CHP as an emissions reduction strategy and EPA's Paul Stolpman promised to consider CHP as a possible Energy Star Building Technology. DOE's new CHP Challenge program will work to eliminate barriers that discourage adoption of CHP technologies and systems. Further information on the CHP Challenge is available at www.oit.doe.gov.

Performance Optimization Tips

Optimizing Your Energy Costs in a Deregulated Environment

By Don Casada, Motor Challenge Program, Oak Ridge National Laboratory

Here in the United States, we have become accustomed to electricity always being available—when we want it and however much of it we want. Our level of dependence has, in the course of less than a century, transformed electricity from the domain of luxury to necessity.

The provision by utilities of reserve margin to accommodate changing load requirements and potential generation loss has been a fundamental part of the electrical infrastructure. And, generally speaking, the electric utility industry has done a fantastic job of meeting our demands. But, there has been an associated cost. We pay for the cost of building the reserve and we pay for the cost of maintaining some of it as standby capacity. Historically, these costs, though real, have often been transparent by virtue of being embedded in the overall rate structure.

As the country moves toward restructuring, these types of costs will become less transparent, particularly for larger users. There will be more rate structures available, and in many cases, the rates will more directly reflect cost components. One of these manifestations will be time of day rates (or even real-time pricing), a structure that is already being used by some industrial customers. These rates inherently reflect the time dependent cost of production of the electrical provider. An example marginal cost of electrical production[1] for two regional groups during a spring and summer week in 1997 is shown in Figures 1 and 2. The marginal cost reflects the incremental cost of energy production at the particular point in time. Note that even in the April time frame, when the cost variation is less than half that for July, there are considerable daily swings.

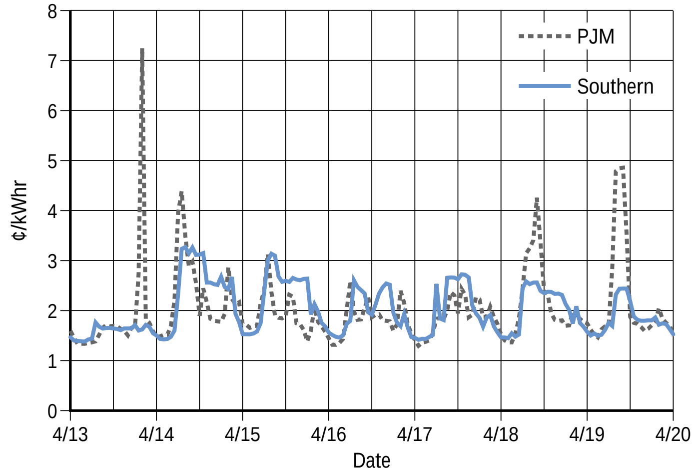

Figure 1. Marginal costs, one week in April 1997

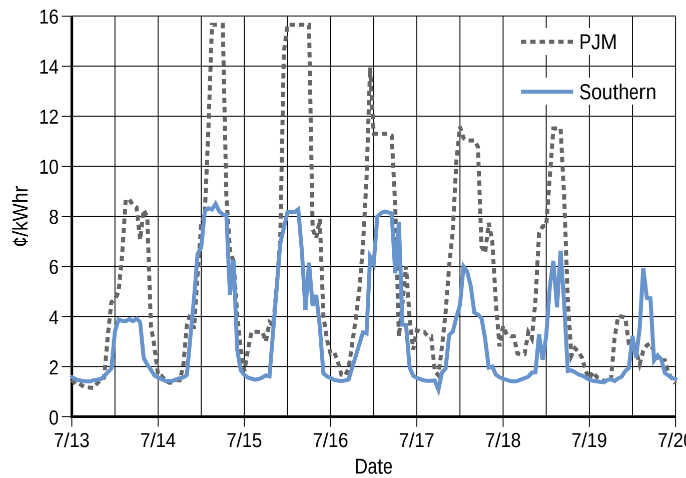

Figure 2. Marginal costs, one week in July 1997
(Note the difference in y-axis scaling for the two figures)

It is important to note that the actual prices paid by end users may vary considerably more than this, particularly at the high end, since the marginal cost does not reflect embedded capital costs.

The Atlanta-Fulton County Water Treatment facility in Alpharetta, Georgia, is already on a rate schedule that approaches real-time pricing, and the plant is making operational and design changes to reduce costs under this new environment. Each day, the local electric utility, Georgia Power, provides the water plant with hour-by-hour cost rates for the following day. The water treatment plant responds to the price schedule by doing most or all of the pumping of raw water from the river to a pre-treatment storage reservoir during low cost hours. Three 1000-hp, 30 million gallon-per-day (MGD) pumps are used for this service, so the loads involved are quite large. According to General Manager Michael Leonard, the plant is recommending more than doubling the raw water reservoir capacity to over one billion gallons, providing more than ten days capacity in storage.

Any form of energy conversion, including kinetic to potential and vice-versa, involves inefficiency. Storage of energy for subsequent use thus inherently involves losses during both the storing and recovery processes. In the case of pumping systems, the principal loss source is friction in the system. For example, if the flow rate is doubled, the energy losses attributable to friction are quadrupled.[2] So if a user simply switches from pumping at a constant flow rate across the course of the day to a scheme where all the pumping is done in half the time at a reduced energy cost rate, the waste frictional energy will *increase,* even though the energy cost may be lower.

But if the user is really smart, the system can also be modified to minimize the negative energy effects of the greater pumping rate and reduce costs even further. For example, in conjunction with the efforts of Atlanta-Fulton County to add more raw water storage capacity, they plan to add a 54-inch pipe (to supplement the existing 54-inch line), thereby doubling the pipe area between the river pumps and the storage reservoir. There is about 7000 feet between the river pumps and the storage reservoir, and since frictional losses are proportional to the length of pipe, close attention to friction is important. Figures 3 and 4 illustrate the frictional head loss and the attendant electrical power requirements just to overcome the pipe friction, assuming clean pipe and 80% wire-to-water efficiency. At a flow rate of 90 MGD, doubled pipe area reduces the frictional power by more than 260 kWe. Thus, the increased pipe area essentially offsets the

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frictional losses that would have otherwise accompanied the higher flow rate operation, making this an energy-neutral change. A side benefit of minimizing frictional losses is that it makes the head against which the pumps operate less variable with the number of operating pumps, allowing them to be more precisely matched to the system.

According to Gary Dodd, Operations Supervisor at the treatment plant, Fulton County has also increased the diameter of the piping in their distribution system, allowing the station to operate at lower discharge header pressure while improving pressure at the far end of the system. Although there is limited storage capacity in the distribution system, the reduced operating pressure at the plant has also significantly reduced on-peak costs, since water demand peaks often are coincident with electrical cost peaks.

The point of this discussion is that in a restructured electric market, the end users who are most flexible in their ability to adjust electrical consumption patterns will be those who profit most. One way of increasing flexibility is to transfer some of the responsibility for reserve capacity from the electric utility grid to the end user. That capacity can take on the form of stored energy, stored product, or an alternative or auxiliary power supply. In the case of the water treatment plant, both product (albeit an unfinished product) and energy are stored in the reservoir. And if it is done in a thorough, systematic fashion, both energy and energy costs can be reduced.

There can be tremendous cost savings opportunities associated with taking on the responsibility of providing the energy and/or product storage capability. Using off-peak hours is clearly a dominant part of that opportunity. But another possibility is to effectively act as virtual *reserve* electrical capacity—i.e., it isn't real capacity, but if it is made available to be shed from the grid, even for relatively short periods, it could have the same effect as putting more generation into service. In the evolving grid control structure, such a capability could well become a sellable commodity. Storage also inherently promotes service availability, helping users to withstand external events such as loss of power and internal problems (such as pump failure).

Those who are preparing for electrical restructuring, like the employees at the treatment facility in Atlanta, will be best equipped to respond to the changing market, and may in fact help influence the restructured environment. It is likewise clear that for those who don't prepare, the times may be very lean.

Send comments to A85@ornl.gov; (423) 576-4271 phone; or (423) 576-0493 fax.

Some areas to consider in preparing for deregulation:

- *Review the facility electrical loads, and identify those loads that can tolerate electrical service interruption, classifying them by the length of acceptable interruption. This list will help not only identify loads that you can currently afford to turn off, but may also help in recognizing areas where improvements could be made.*
- *Inquire with your electrical service provider about alternative rate schedules, such as real-time pricing. You can use this information to not only optimize your current electrical costs but to help clarify the cost-effectiveness of on-site solutions, such as those identified below.*
- *Provide more storage capacity for the product if the product turnover time period is short (such as in a water treatment system).*
- *Store energy that can be used in lieu of active energy from the grid (in the case of liquid in elevated storage, the product of the mass and elevation of the liquid represents stored energy).*
- *Minimize friction losses in pumping systems to support high fluid transfer rates during off-peak hours. This may mean increasing pipe sizes or providing parallel pipe sections.*
- *Consider alternative energy sources for short duration use. On-site power sources can provide not only emergency power, but can be used during periods when grid power is particularly high.*

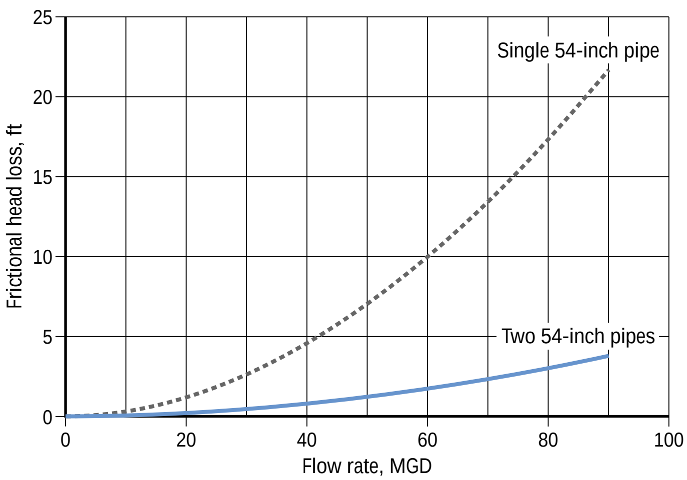


Figure 3. Frictional head loss, 7000 feet of clean pipe

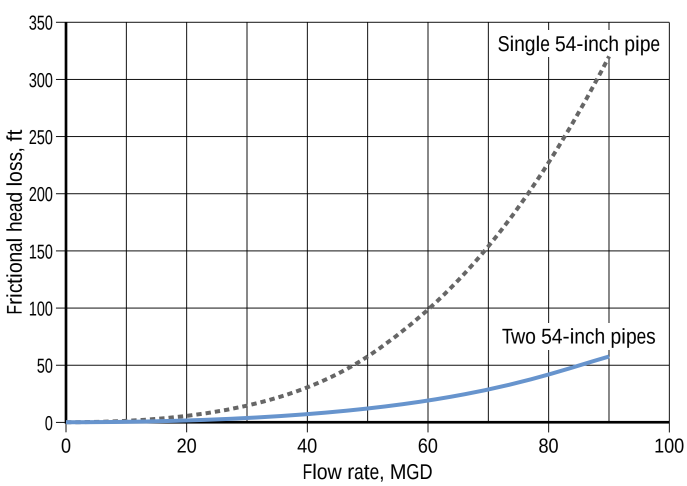


Figure 4. Electrical power required to overcome frictional head loss, assuming 80% wire-to-water efficiency

Acknowledgements
The author appreciates the information provided by Michael Leonard, Gary Dodd, and Waymon Jones of the Atlanta/Fulton County Water Treatment Plant, Steve Bolles of Woodard & Curran, and Brendan Kirby and John Kueck of ORNL.

[1]Source: Resource Data International (http://www.resdata.com) POWERdat Information System.

[2]Frictional *power* increases by a factor of eight when the flow rate is doubled (and nothing else is changed), but if the goal is to move a given volume of fluid, the pumps would only run half as much if the flow rate were doubled, and thus the frictional *energy* is only four times that for the lower flow rate.

The Northeast Premium Efficiency Motor Initiative

The Northeast Premium Efficiency Motor Initiative hit full-scale implementation last June. The Initiative is a combined effort of 23 electric utilities in Vermont, Massachusetts, Connecticut, Rhode Island, and New Jersey. Its goal is to increase the availability, sale, and purchase of "Initiative Qualifying" 3-phase electric motors so they become the "products of choice" for end users when purchasing decisions are made.

The Northeast Energy Efficiency Partnerships (NEEP) was integral in designing the Initiative. Initiative planning included aligning the Initiative with the Motor Challenge Program and utilizing the program specifications outlined by the Consortium for Energy Efficiency (CEE). Through a competitive bidding process, the utilities selected Applied Proactive Technologies, Inc. (APT) of Springfield, Massachusetts, to deliver the Initiative to the field.

Motor Challenge provided the Initiative and utility personnel with training on *MotorMaster+* software and the availability of other resources through the program.

Upon motor failure, customers can either repair or replace their motor. They can (1) rewind the failed motor, (2) buy an EPAct efficient motor, or (3) purchase a premium efficiency motor that meets the CEE levels, which are somewhat higher than efficiency levels set by EPAct.

The Northeast Premium Efficiency Motor Initiative provides financial incentives to customers to cover a portion up to the full "incremental cost difference" between an EPAct motor and an "Initiative Qualifying Motor." (See table.) Motors included in the initiative are NEMA design A and B, electric, 3-phase, Open Drip Proof (ODP) and Totally Enclosed Fan Cooled (TEFC) 1200, 1800, and 3600-rpm motors between 1-200 horsepower, which meet the CEE efficiency levels. The largest savings for the customer are in purchasing and properly applying the most energy-efficient motor. The incentives provided by the Initiative make it an even easier decision.

Initiative participants receive comprehensive training, which includes Point-of-Purchase materials such as brochures and display stands; an efficient motor selection guidebook pamphlet; a slide presentation; Initiative logos for advertising slicks; Rolodex cards; qualifying motors per manufacturer quick-reference-cards; and DOE materials. They also receive training on how to sell energy efficiency to customers.

Open Drip-Proof (ODP)
Premium Efficiency Motor Incentives

Size HP	NEMA Nominal Efficiency Speed (RPM) 1200	1800	3600	Customer Incentive ($/Motor)
1	82.5%	85.5%	80.0%	$36
1.5	86.5%	86.5%	85.5%	$36
2	87.5%	86.5%	86.5%	$36
3	89.5%	89.5%	86.5%	$41
5	89.5%	89.5%	89.5%	$50
7.5	91.7%	91.0%	89.5%	$59
10	91.7%	91.7%	90.2%	$68
15	92.4%	93.0%	91.0%	$81
20	92.4%	93.0%	92.4%	$90
25	93.0%	93.6%	93.0%	$117
30	93.6%	94.1%	93.0%	$135
40	94.1%	94.1%	93.6%	$162
50	94.1%	94.5%	93.6%	$198
60	95.0%	95.0%	94.1%	$234
75	95.0%	95.0%	94.5%	$270
100	95.0%	95.4%	94.5%	$360
125	95.4%	95.4%	95.0%	$540
150	95.8%	95.8%	95.4%	$630
200	95.4%	95.8%	95.4%	$630

Totally Enclosed Fan-Cooled (TEFC)
Premium Efficiency Motor Incentives

Size HP	NEMA Nominal Efficiency Speed (RPM) 1200	1800	3600	Customer Incentive ($/Motor)
1	82.5%	85.5%	78.5%	$40
1.5	87.5%	86.5%	85.5%	$40
2	88.5%	86.5%	86.5%	$40
3	89.5%	89.5%	88.5%	$45
5	89.5%	89.5%	89.5%	$55
7.5	91.7%	91.7%	91.0%	$65
10	91.7%	91.7%	91.7%	$75
15	92.4%	92.4%	91.7%	$90
20	92.4%	93.0%	92.4%	$100
25	93.0%	93.6%	93.0%	$130
30	93.6%	93.6%	93.0%	$150
40	94.1%	94.1%	93.6%	$180
50	94.1%	94.5%	94.1%	$220
60	94.5%	95.0%	94.1%	$260
75	95.0%	95.4%	94.5%	$300
100	95.4%	95.4%	95.0%	$400
125	95.4%	95.4%	95.4%	$600
150	95.8%	95.8%	95.4%	$700
200	95.8%	96.2%	95.8%	$700

As a value-added service and to assist in the identification and selection of qualifying motors, the Initiative provides participating distributors with a copy of *MotorMaster+* software. The software enables distributors to provide customers with a print out of the estimated energy and dollar savings. With the Initiative's incentive included in the calculation and the first cost reduced or eliminated, it is easy for customers to see the benefits associated with purchasing the more energy-efficient Initiative Qualifying motor. Distributors also make the software available to their customers.

The Initiative has targeted, and is actively enlisting, the participation of over 350 motors distributors within the service territories of the participating utility companies. Close to 1,500 of the distributors' staff have been trained on the Initiative's policies as well as on *MotorMaster+*.

How does the end user benefit?

The real winners are the customers or the end users of the motors and the environment. The customers receive:

- The cash incentive that results in a payback that can be immediate for motors under 50 hp to 3 years for the larger motors.
- Reduced costs on the "2nd price tag" (the energy cost of operating the motor over the years), which can be thousands of dollars in electricity per motor.
- Increased reliability from a motor that runs cooler.
- Extended manufacturers' warranties.
- Better constructed motors.
- The avoided cost benefits from unplanned downtime and production losses.
- Increased competitiveness by lowering operating costs.
- Access to *MotorMaster+ 3.0* software.

Utility representatives and Initiative personnel will assist customers with completing the paperwork. To date, over 700 rebateshave been paid totaling over $50,000. The Initiative expects to provide incentives to the tune of $700,000 for 1999.

Here's an example of the savings you, as a customer, can expect: You purchase an EPAct efficient (93%), 40-hp, 1800 rpm, TEFC motor for $2200, which would obligate you to buy $17,948 in energy a year (8740 hrs/year, $0.08/kWh, 80% load). You would need to spend $500 more to purchase the most efficient motor (94.6%) for the job, but that motor would save you over $300 a year in energy costs or $3000 over the motor's life.

(continued on page 9)

continued from page 8

With the initiative's cash incentive of $180, it would cost only $320 more to purchase the qualifying premium efficient motor over the EPAct one. With annual savings of $300 a month, that is a payback of 1.06 years.

Choosing the option of rewinding a 40-hp standard efficient motor (88.4%) would cost you $880 on average. However, rewinding would result in a 2% efficiency loss and would cost you approximately $18, 887 in annual energy costs—$1239 more than if you went with the qualifying premium efficient motor and $939 more than with an EPAct model. Choosing the most efficient motor for the job over rewinding would result in a 1.3 year payback.

As this example shows, you will benefit the most by purchasing a qualifying premium efficient motor over an EPAct motor and rewinding. However, to achieve the greatest savings, you must properly install and apply the motor within your specific system—especially for centrifugal fluid system loads (e.g., pumps and fans). *MotorMaster+* can help you evaluate these specific applications.

Not only does the customer benefit from purchasing the most efficient motor, but the environment benefits from the reduced carbon emissions that are displaced from the generating plants burning less fossil fuel (coal and oil) to produce the energy. In addition, this reduces the need to build new power plants.

For the Northeast Region, if all the motors sold represented a 2% efficiency increase over EPAct, then the region could save 36 GWh per year and millions of pounds of carbon emissions.

According to Ipsita Ganguili, Program Administrator for the Initiative, "working with Motor Challenge has been a tremendous resource for the Initiative. The distributors view the software, the case studies, and the demonstration studies as useful sales tools and the Clearinghouse as a valuable resource for them as well as their customers."

For more information on the Initiative, call 1-888-45MOTOR (456-6867).

Motor Challenge Partner McBroom Electric Helps Customer Save Energy and Money

Between 1996 and 1998, McBroom Electric Company Inc. initiated and successfully completed the biggest and most complex project in its 66-year history. The project? A million-dollar installation of nearly 800 energy-efficient motors, totaling over 13,000 horsepower, at the Cummins Engine Company in Columbus, Indiana. The installation saves Cummins an estimated $200,000 per year in motor energy costs.

Indianapolis-based McBroom Electric sells, repairs, and maintains electric motor-driven systems for a wide range of industrial customers. As a Motor Challenge Allied Partner, McBroom uses several Motor Challenge tools and publications, but has found *MotorMaster+* software, the Motor Challenge case studies, and the fact sheet entitled "Frequently Asked Question on the Energy Policy Act of 1992" to be particularly valuable when working with customers.

McBroom put some Motor Challenge tools to use while managing the installation of the energy-efficient motors in Cummins' existing and new machining lines. As a participant in Cummins' Joint Energy Committee, McBroom was invited to perform a comprehensive audit of the motors in Cummins' manufacturing process. "We utilized *MotorMaster+* software to do the inventory," says Bob Campbell, McBroom vice president of sales, "and based on what Cummins had in place, we were able to project a very short payback period for energy-efficient motors versus the standard units they were using."

As a result, Cummins decided to change-out an initial 300 motors on its engine block, rod, and insert machining lines and replace them with energy-efficient T- and U-frame motors. The replacement occurred over 12 months, with most of the work performed on weekends and scheduled shutdowns. According to Howard Stogdill, maintenance manager of the Columbus assembly plant, "Doing this replacement was a major maintenance process for us, and it brought up other issues like couplings, belts, and pumps…"

The second installation took place on two machining lines being constructed to manufacture the new Signature 600 engine. These lines used a total of 500 motors ranging in size from ½ to 200 horsepower. McBroom's analysis showed that Cummins could save $128,000 in annual energy costs on the new lines with energy-efficient motors.

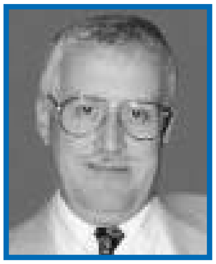
"The benefit to McBroom is that Motor Challenge has provided us with a lot of tools and resources…that help us provide better service to motor users…and even though we had our own motor audit system, using things like the *MotorMaster* raw data sheets makes us more efficient and keeps us from having to reinvent the wheel," explains Campbell.

U.S. Electrical Motors Plays a Role

Motor manufacturer U.S. Electrical Motors (USEM) has been involved in the Motor Challenge Program since 1993. Over the years, USEM has participated in various Motor Challenge activities that have provided an opportunity for them to forge new business relationships. One such activity was the 1995 Motor Challenge Efficient Motor Systems teleconference, hosted at the Indiana University and Purdue downlink site by McBroom Electric (a USEM distributor). A Cummins Engine Company employee attended the teleconference and initiated discussions with McBroom Electric and USEM that eventually lead to the million-dollar installation of energy-efficient motors at Cummins' assembly plant in Columbus, Indiana. USEM worked through McBroom Electric, the lead on the project. "It was a wonderful opportunity to attend a jointly sponsored event by one of our distributors and have it ultimately result in a total order value for USEM of over a million dollars . Cummins also benefited by choosing the most energy-efficient motors available for the job," explains Rob Boteler, USEM.

Root Cause Failure Analysis On AC Induction Motors

By John M. Machelor, Motor/Drives Systems Specialist, Motor Challenge Program, MACRO International Inc.



This is the third in a series of articles by Mr. Machelor. In the September 1998 issue, John focused on some of the most common electrical failure modes of in-service induction motors and how to identify their root causes. The present article continues this focus.

Undervoltage: This root cause condition, which occurs when the supply voltage is more than 10% lower than the motor rated voltage, frequently results in motor overheating. As the motor's supply voltage is reduced, the motor's current draw will increase because the motor needs constant power (volts x current) to supply the constant external load. As discussed in the September 98 article, motor heating increases with current with resultant detrimental effects on the motor's insulation.

Up until now, we have focused our attention on root causes resulting in excessive heat being generated within the motor itself (windings/core iron). There is another group of conditions that, when present, interfere with the motor's ability to cool itself. The end result, however, is the same—excessive heat leading to premature insulation failure. These conditions are associated with the application environment of the motor. They include: (1) partially/totally blocked ventilation passages, (2) damaged/destroyed external cooling fans, (3) foreign substance buildup on motor surfaces, (4) motor operating at higher than rated altitude, (5) motor operating at higher than rated ambient temperature, and (6) motor operating in direct sunlight for long periods of time. Contamination is the root cause of conditions (1), (2), and (3), while misapplication/ignorance is the root cause of conditions (4), (5), and (6). Let's look at contamination first.

Most contamination occurs in the air surrounding the motor in the form of chemical agents, particulates, dirt, etc. Chemicals and acids can attack and destroy external cooling fans, especially aluminum ones. Also, particulates/dirt can build up on fan blades causing imbalance of the fan and eventual cracking and breaking off of blades. Particulates/dirt can also build up on the motor surfaces themselves blocking cooling air ventilation passages as well as "blanketing" the motor so as to interfere with normal heat transfer from the motor to the outside air.

Conditions like altitude, ambient air temperature, and sunlight easily can be overlooked when applying motors. "Standard" AC induction motors meet NEMA requirements of 3300 feet maximum altitude. At higher altitudes, the thinner air reduces motor cooling ability so that a standard motor will run hotter under these conditions. Likewise, NEMA defines the maximum ambient temperature for a standard induction motor as 40° C (104° F). At higher ambients, a standard motor will run hotter.

I want to use the condition of direct sunlight to summarize the foregoing discussion as well as to illustrate an actual situation I encountered while running a Reliability Based Maintenance (RBM) program at a large end user. The situation was such that dozens of pump motors were being exposed to not one but ALL SIX of the adverse environmental conditions just described. Most of the motors had partially or totally blocked vent passages. Most of the motor external cooling fans were either damaged or missing entirely! A black tar-like contaminant covered the surface of most of the motors. To add insult to injury, these pump motors were operating at higher than normal altitude and ambient temperature, and were exposed to summer sun all day long. The failure rate for these poor units was 20% per month and the failures were almost entirely due to insulation breakdown from excessive heat! This unfortunate situation illustrates two very important points: (1) a pre-mature motor failure can be attributed to one root cause only, but is more likely due to multiple root causes "teaming up" together; and (2) an established RBM program will go far to identify and eliminate these root causes.

There is one significant cause of insulation breakdowns that is unrelated to excessive heat. That cause is high humidity conditions, which result in condensation on the motor insulation even though the motor is totally enclosed. This problem usually results from two scenarios: (1) long-term storage of the motor in a warehouse where there is no controlled environment and (2) alternate heating/cooling (on/off) cycling of the motor that occurs under normal service conditions. In either case, long-term exposure of the insulation to excessive moisture can gradually weaken it to the point of breakdown. A controlled environment warehouse with regulated humidity levels will solve problem (1). Problem (2) can be addressed by the use of single-phase space heaters wrapped around the stator end turns or providing a low-level DC "trickle current" through one of the motor's phase windings during off periods. Either method helps to keep the inside of the motor dry and condensation-free.

The next article will address root causes of mechanical motor failures.

For these articles, the author draws on over thirty years of experience in the design and application of AC induction motors. Readers are welcome to send questions, comments, or suggestions to John Machelor at:
E-mail: jmachelo@macroint.com or macrojmm@aol.com
Phone: (540) 639-4271
Fax: (540) 639-4272

Compressed Air Challenge™ Announces First Wave of One-Day Training Sessions

The Compressed Air Challenge™ has announced the schedule for its first wave of Level-One training sessions. The training is focused on ways to improve productivity, energy savings, and profitability through better planning and operation of compressed air systems. Level-One training is targeted to plant engineers, maintenance supervisors and other industry personnel responsible for compressed air systems within an industrial or commercial setting.

The one-day session will include information on how to calculate the energy costs of compressed air systems, how to cut the cost of operating these systems, and strategies for improving system efficiency and reliability.

The first wave of one-day training sessions will be held beginning in February 1999. The schedule is as follows:

- Chicago . . . . February 18, 1999
- Las Vegas . . . . . . February 22, 1999
- Dallas . . . . March 1, 1999
- Newark . . . . March 8, 1999
- Atlanta . . . . March 15, 1999

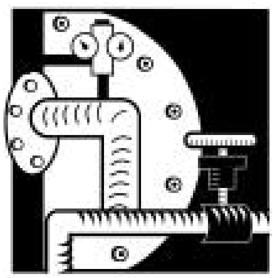
Additional Level-One training will be offered throughout 1999 at various locations across the United States.

The Compressed Air Challenge is a national initiative created by industry, government, and not-for-profit volunteers committed to improving the efficiency and reliability of industrial and commercial compressed air systems—ultimately leading to reduced operating costs and increased production.

For more information on training sessions and related materials available through the Compressed Air Challenge, call toll-free 1-800-862-2086.

Steam Challenge: Improve Your Boilers and Steam Distribution

There are many opportunities to improve the efficiency of both boilers and the steam distribution system through improved maintenance and operation. Here are a few examples how:



Water Treatment—This is an important aspect of boiler operation that can affect efficiency or result in plant damage if neglected. Without proper water treatment, scale can form on boiler tubes, reducing heat transfer and causing a loss in boiler efficiency by as much as 10 to 12 percent. Water treatment represents a substantial portion of overall boiler operating costs. Therefore, improved efficiency throughout the steam system reduces this significant operating cost.

Condensate Return—Recovering hot condensate for reuse as boiler feed water is another way to improve system efficiency. The energy used to heat cold makeup water is a major part of the heat delivered for use by the steam system, requiring an additional 15 to 18 percent of boiler energy for each pound of cold makeup water.

Load Controls—There have been great advances in boiler control technology as older pneumatic and analog electronic control systems have given way to digital, computer-based distributed control systems. These systems are more reliable and can extend boiler life. Modern, multiple burner control, coupled with air trim control can result in fuel savings of 3 to 5 percent. For example, a boiler economic load allocation system optimizes the loading of multiple boilers providing steam to a common header so as to obtain the lowest cost per unit of steam. Honeywell Inc.'s Industrial Automation and Control Division commonly recommends this technology to help customers reduce boiler fuel consumption by 1 to 3 percent and improve performance.

For information on the Steam Challenge program or steam efficiency issues call (800) 862-2086.

Pump Sourcebook Can Help Improve Pump Systems

NEW Motor Challenge is publishing a new reference book on energy efficiency in pumping systems for industry. *Improving Pumping System Performance: A Sourcebook for Industry* is the second in a series of sourcebooks developed by Motor Challenge. A sourcebook on compressed air systems optimization is also available, and sourcebooks on fan systems optimization and motor & drives are under development.

The sourcebook provides an overview of industrial pumping systems, a roadmap for identifying system improvement opportunities, 12 fact sheets detailing these opportunities, a directory of programs, resources, and tools, and other relevant information.

The Hydraulic Institute members of the Life Cycle Cost Committee provided input to Motor Challenge on the Sourcebook. Call the Challenge Programs Information Clearinghouse at (800) 862-2086 for information on availability and cost of this publication.

Learn from Experience

Order a copy of *Learning from Experiences with Industrial Electric Motor Drive Systems,* CADDET Analysis Series No. 24. This report outlines the principles of electric motors and variable speed drives. It examines the major barriers to the acceptance of energy-efficient systems along with the national practices and programs of many CADDET member countries. The report contains more than 30 demonstration projects from 11 CADDET member countries, covering all aspects of industrial drive systems. The lessons learned from these projects are summarized in a convenient checklist.

Order your copy by calling Eric Stragar, American Council for an Energy-Efficient Economy, at (202) 429-0063. The publication cost is $45.00.

Coming Events

Get Ready to Turn Your Visions into Reality

The Third Industrial Energy Efficiency Symposium and Exposition, “Turning Industry Visions into Reality,” is set for February 7-9,1999, in Washington, D.C. Mark your calendar to attend this national conference on energy efficiency and clean manufacturing in U.S. industry. The event will highlight leading-edge thinking and advanced technologies to meet emerging energy, environmental, and market demands. Check out the Web page at www.oit.doe.gov for current information on this conference, or call (877) OIT-SYMP.

International Forum for Energy Efficiency Developments

On September 20-22, the 2nd International Conference on Energy Efficiency in Motor Driven Systems will be held in London, United Kingdom. This event, cosponsored by the U.S. Department of Energy, builds on the success of the 1996 Lisbon Conference, providing an international forum for energy efficiency developments in motors, drives, and their applications. Deadline for workshop and poster session papers is February 28, 1999. Call +44 1235 432383 or e-mail carol.johnstone@aeat.co.uk for more information.

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Information Clearinghouse

Do you have questions about using energy-efficient electric motor systems? Call the OIT Challenge Programs Information Clearinghouse for answers, Monday through Friday 9:00 a.m. to 8:00 p.m. (EST).

HOTLINE: (800) 862-2086

Fax: (360) 586-8303, or access our homepage at www.motor.doe.gov

DOE Regional Support Office Representatives

- Tim Eastling, Atlanta, GA, (404) 347-7141
- Lili Griffin, Boston, MA, (617) 565-9714
- Julie Nochumsom, Chicago, IL, (312) 886-8579
- Gibson Asuquo, Denver, CO, (303) 275-4841
- Julia Oliver, Seattle, WA, (510) 637-1952
- Maryanne Daniel, Philadelphia, PA, (215) 656-6964

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